The Glass Industry
REG. U. S. PAT. OFF.

Vol. 13 AUGUST, 1932 No. 8

Use of Electrochemical By-Products in Glass Making

1. Arsenic, Selenium, Tellurium [1]

By ALEXANDER SILVERMAN [2]

ABSTRACT

THE conclusions that can be drawn from the work of the many serious investigators cited are: Arsenious oxide takes oxygen during the early stages of a melt and is a balancing agent in insuring lack of color in the finished glass. Used in reasonable amounts in soda lime glasses, its effects are beneficial except as claimed by some investigators that glasses may turn yellow under solar radiation. Converting ferrous ion to ferric ion, arsenious oxide facilitates penetration of heat rays into the melt, resulting in higher furnace temperatures or in fuel economy. It facilitates fining in lead glasses, but is objectionable where these must be subjected to subsequent heating as in the lamp work on tubing which may darken. The presence of arsenious acid in chemical glassware is undesirable. Its stirring action in glass melting is doubtful. Its influence as a flux is questionable. Finally, the effects produced by arsenic are evidently desirable in many instances. Although selenium was first employed in 1865 by Pelouze, comparatively little is as yet definitely known regarding its chemistry in glass making. From 0.5 to 1.0 per cent of selenium is employed extensively in the manufacture of red zinc glasses under reducing conditions. Less selenium is required for the desired color in potash glasses than in soda glasses. Selenium apparently is as effective in color production as the selenites and is less expensive on the basis of equivalent weights of the element. The black variety is commonly employed. Cadmium sulfide is employed with selenium in practically all the desirable red glasses. Carbon or sulfur is usually employed as a reducing agent in selenium red glasses. Arsenious or antimonious oxides are employed in selenium red glasses and the former is superior. The selenium red color is usually brought out under heat treatment. A number of arseno-sulfur compounds of selenium, which range from light red to purplish black, are known. Investigations are under way to determine whether these are formed in selenium red glasses and whether the compounds may be utilized directly for the production of the color. Investigation by the author are under way to determine whether the color produced is due to colloids or to selenium compounds. If the latter is true, an attempt will be made to determine their nature. Under oxidizing conditions in lime glasses containing potash, and practically free from iron, selenium produces a pink color. In soda lime glasses, the element produces an orange color in the presence of a reducing agent. In lead glasses, the element produces an amber color in the presence of niter. Selenium is effectively employed in low concentration as a decolorizing agent, especially for soda lime glasses. Arsenious oxide serves as a control. Investigations on tellurium indicate color producing tendencies like those of selenium. No commercial applications have as yet been made. Further investigations may render these possible.

INTRODUCTION

The Bureau of the Census, Washington, D. C., in its Biennial Census of Manufacturers, indicates that during 1930 the products of the glass industry were valued at $299,717,063. Most of the products are manufactured from batch in which arsenious oxide is employed with various decolorizers such as selenium, manganese dioxide, the oxides of cobalt, nickel, cerium, neodymium, etc. In some instances the arsenious oxide and selenium are employed as coloring agents. Mineral Resources of the United States report that in 1930, 14,654 short tons (13,291 metric tons) of refined arsenious oxide were sold, of which about 5 per cent was employed in glass manufacture, selling in large lots at 4 cents per lb. (8.8 cents per kg.). During the same year, 278,309 lb. (126,241 kg.) of selenium were sold at prices in large lots ranging from $1.80 to $2.00 per lb. ($3.96 to $4.40 per kg.). No indication is given of the amount em-

[1]Paper No. 234 from the Department of Chemistry, University of Pittsburgh, Pittsburgh, Pa. Manuscript received March 16, 1932.
[2]Head of the Department of Chemistry, University of Pittsburgh.

ployed in glass manufacture. During this year 4,719 lb. (2,141 kg.) of tellurium were sold at a price averaging $1.70 per lb. ($3.74 per kg.). This item does not include considerable quantities which were furnished gratuitously for research purposes. That tellurium is used in actual glass manufacture is doubtful. As arsenious oxide, selenium and tellurium are by-products in the sludge in the electrolytic refining of copper, it will be of interest to learn something concerning the history of their utilization in glass making and the extent to which they are employed today, together with information about the function of these substances in the glass batch.

ARSENIC

Arsenic is introduced into the glass batch as arsenious oxide, which is referred to erroneously in glass literature as arsenic, white arsenic and arsenious acid.

History

In the excavations made to uncover the ancient city of Herculaneum, cast panes of glass were unearthed which represented a type employed in the baths and greenhouses in Pompeii. An analysis of these panes disclosed a striking similarity in composition to plate glass manufactured in France in comparatively modern times. 0.39 per cent of manganese was reported in the Pompeiian glass. It is not known whether arsenious oxide was employed with manganese dioxide as it is today, and no arsenic is disclosed in either the analysis of the Pompeiian or French glass. Centuries before, arsenic and antimony compounds were a part of cosmetics in Egypt, and as early investigators tried most of the known minerals of their day, these may have been used in glass making. In 1677, Johann Kunckel produced gold ruby glass in Germany. Most of the old gold ruby formulas which have been handed down contain arsenic compounds. However, there seems to be no definite reference to the use of arsenic in glass making until the beginning of the eighteenth century when a German work appeared, entitled, "The Laboratory, or School of Arts." A translation of this was made in London in 1739 by G. Smith. It refers to the use of arsenic as a flux, with niter. In a "Treatise on Origin, Progressive Improvement and Present State of the Manufacture of Porcelain and Glass," published by Longmans in London in 1832, arsenic is recommended for correcting the color due to excessive use of manganese, and warning is given that with too much arsenic the glass becomes cloudy. Already in 1854, William Gillander, in America, employed arsenic and he mentions it in his "Treatise on Glass Making" of that year. He considers it useless as a coloring agent in flint glass. It is difficult to interpret just what is meant by this statement, and it must be borne in mind that the opinion refers to lead glass at a time when the function of arsenious oxide in selenium decolorizers and in the production of colored selenium glasses was not known.

Uses and Opinions

E. Tseuschner[3] made the statement that arsenious oxide stirs the melt but does not remain in the glass, and that if it should remain, the glass would have a low resistance to weathering and would become iridescent. Tseuschner thought that arsenious oxide was reduced to elementary arsenic and vaporized. He also mentioned that the arsenic corrected the color due to excessive use of manganese dioxide. In 1897, J. Henriveaux[4] claimed that arsenious oxide assisted in the melting of the glass, but expressed his preference for the use of sodium arsenate. Otto Schott,[5] the dean of glassmakers of all time, in 1902 stated that while arsenic is introduced into the batch as trioxide, it is undoubtedly present in the glass as pentoxide, combined with alkali, or in other words, as arsenate. This, in his opinion, is true in the presence of oxidizing agents and he further states that no arsenic remains in plate and sheet glass, because, in the absence of oxidizing agents it is driven off as a vapor. In 1909, R. L. Frink[6] claimed that arsenic increased the crushing strength of window glass, but no data were given. R. Dralle[7] supports the earlier ideas of Tseuschner as to volatility, mentioning the corrective value in decolorizing not only with manganese dioxide, but also with selenium.

The first step toward reforming opinions concerning the effects produced by arsenious oxide was taken in America about 1910, when the writer[8] questioned the value of this expensive material as a stirring and fining agent. In 1912, F. Gelstharp[9] reported that 56 per cent of the arsenic left in glass was pentavalent and that no arsenious oxide was present in glass, even when manufactured under reducing conditions. The following year, S. R. Scholes[10] reported that the trioxide was not expelled, but mostly held in crown and flint glasses after conversion to pentoxide. In 1914, another article by Gelstharp[11] claims the conversion of arsenious oxide to sodium arsenate according to the reaction

$$As_2O_3 + 3Na_2CO_3 + O_2 \longrightarrow 2Na_3AsO_4 + 3CO_2.$$

The oxygen is provided by niter at a low temperature, but arsenious oxide takes and holds it for conversion of ferrous ion to ferric ion. Arsenious oxide may also take oxygen from sodium sulfate of salt cake. In 1915, the beneficial effect of arsenious oxide in window glass manufacture was questioned by C. J. Brockbank,[12] who further called attention to the fact that the arsenic may at times cloud the glass and make the panes unstable to solar radiation. In 1918, B. J. Allen and E. G. Zies[13] claimed a loss of less than 30 per cent of arsenic introduced into their batches, some of which contained niter. L. Springer[14] claims that both arsenious oxide and niter are necessary for effective work.

W. E. S. Turner[15] and his collaborators in England began the publication of a series of articles in 1922, in which much light is thrown on the function of arsenic in glass making. These investigators found that in soda lime glasses, arsenious oxide has no stirring action; that it does not act as a flux unless used in large quantities; that it is largely converted from trivalent to pentavalent arsenic; that it

[3]Die Glasfabrikation, pp. 23, 124, Dresden (1885).

[4]La Verre et la Crystals 397 (1987).
[5]H. Hovestadt, "Jena Glass and Its Scientific and Industrial Applications." Translation by J. S. and A. Everett. London (1902).
[6]Trans. Am. Ceram. Soc., 11, 313 (1909).
[7]Die Glasfabrikation I, 186 (1911).
[8]Trans. Am. Ceram. Soc., 12, 193 (1910).
[9]J. Ind. Eng. Chem., 4, 16 (1912).
[10]Trans. Am. Ceram. Soc., 15, 505 (1913).
[11]Trans. Am. Ceram. Soc., 16, 284 (1914).
[12]Trans. Am. Ceram. Soc., 17, 222 (1915).
[13]J. Am. Ceram. Soc., 1, 787 (1918).
[14]Sprechsaal, 47, 361 (1914), 50, 166 (1917).
[15]J. Soc. Glass Tech., 6, 169 (1922); 7, 309 (1923); 9, 111 (1925); 10, 3, 20 (1926); 11, 65, 190, 205 (1927).

changes ferrous ion to ferric ion and corrects excessive color due to selenium or manganese dioxide; that the preceding glasses turn yellow under solar radiation. In lead glasses they find that, up to two parts per thousand of sand, arsenic improves the working quality of lead potash glasses, but that the tubing darkens in lamp work. They question the advisability of introducing arsenic compounds into chemical glassware. They find no reason for questioning the presence of small quantities of arsenic in glass used for food containers.

Turner and collaborators consider it safe to use up to two parts of arsenious oxide per thousand of sand in soda lime batches, but admit that with high silica batches, scum may form in the melt. Their experiments included as much as 150 parts of arsenic per thousand of sand. With the increasing quantities of the arsenic compound, various degrees of opacity resulted. When less than 2 per cent of arsenious oxide is used, more than 80 per cent is present as pentoxide in the glass, and in soda-lime glasses 75 to 100 per cent of the arsenic is retained in the glass, even if up to five parts per thousand of sand are used; after glass has stood in tanks from five to seven days, from 55 to 100 per cent of the arsenic still remains in the glass in pentavalent form. Turner and his associates feel that niter should be used with arsenious oxide and that the latter alone will not produce satisfactory results. They further intimate that a higher temperature results in the glass through the presence of arsenic, finding it possible to operate tanks up to 1,500° C. in the presence of niter, with an arsenic loss which is still insignificant. E. Zschimmer, E. Zimpelmann and L. Riedel[16] claim that with a rise of temperature, trivalent arsenic again forms and the glass is off color. Turner's group questions this, stating that arsenates are formed and have a definite effect in decolorizing, even independent of selenium. Zschimmer, Zimpelmann and Riedel further discuss the relative fining values of salt cake and arsenious oxide on aluminous soda-lime glasses containing up to 12 per cent of aluminum oxide. Less scum was formed in the arsenic melts than in the sulfate melts, and the former glasses could be plained readily while the latter with difficulty or not at all.

Amounts of arsenious oxide employed in glass batches may be gained from Hodkin & Cousen's "Textbook of Glass Technology." Briefly, they are 0.07 per cent for pressed lime ware and for glass blown in machines. These glasses usually also contain selenium and in some instances powdered blue (a pulverized glass containing 2.5 to 6 per cent of cobalt oxide). For table flint 0.12 per cent is introduced and for hand blown bottles containing no decolorizer 0.5 per cent.

Contradicting the claim of D. J. McSwinney[17] that arsenious oxide attacks refractories in the refining end of tanks, Turner[18] feels that arsenic, after conversion to the pentavalent form, oxidizes ferrous ion to ferric ion with the result that heat rays pass through the glass more readily, thus producing a higher temperature at the tank block surface, which results in greater corrosion by the glass.

[16]Sprechsaal, 53, 331, 353, 393, 411, 422 (1926).
[17]J. Am. Ceram. Soc., 8, 307 (1925).
[18]J. Am. Ceram. Soc., 9, 412 (1926).

SELENIUM AND TELLURIUM

Red Glasses

In 1865, the French chemist, J. T. Pelouze, announced a method for staining glass rose red by the incorporation of elementary selenium in the batch, or by introducing the selenium into the glass after the batch had partly melted. In 1893, British patent No. 16,018 was granted to Messrs. H. R. and W. R. von Kralik of Austria for the use of selenites or selenates in the manufacture of red glass, either by admixture with the batch or addition to the partly molten glass. This introduction to the history about tells the story of forms of selenium employed in glass making. The element may be utilized in the red or black form and the salts are usually those of sodium. The von Kraliks claimed originality in their patent because, in the preparations of the salts, pure selenuim compounds could be introduced into the glass instead of selenium which was evidently quite impure in those days, containing considerable quantities of iron. As selenide of iron is black, the presence of iron is considered undesirable for the production of a good red, the color verging on brown in its presence.

Selenium or sodium selenite is usually introduced into the batch with cadmium sulfide, arsenious or antimonious oxide and a reducing agent such as charcoal, tartaric acid, sugar or sulfur, for the production of ruby glass. Pulverized metals, such as zinc and aluminum have been suggested as reducing agents, but the writer has not had success with zinc, and has had uncertain results with aluminum.. Best results are obtained in batches in which zinc oxide is used to a rather large extent, entirely or almost entirely replacing lime. Deeper colors are obtained with potash glasses than with soda glasses. These glasses are best produced in pots which are closed during the melting of the batch, with the mouths carefully clayed up to prevent loss of selenium through volatilization, as much as possible. When the pot is opened, the glass which is withdrawn has a black color, but, on cooling on a pipe, may become light amber or almost colorless. On reheating, it again becomes black and on cooling is red. The tendency of red substances to change color with temperature was mentioned by the writer in 1914.[19] It is present not only in selenium and other red glasses, but in such substances as the red oxide of mercury, which turns black on being heated in a test tube, returning to its red color again on cooling and becoming yellow when the tube is immersed in liquid air. From 1912 to 1914, a series of articles was published by P. Fenaroli,[20] of Italy, who claimed the variation in color from brownish through pink to red, due to colloidal particles 40 m μ or less in size. He felt that these were produced more readily in potash glasses, which are more viscous than soda glasses. O. N. Witt[21] and E. Fränkel[22] claimed the silica content of glass a factor in the type of color produced. Fränkel states that only 0.06 per cent of the selenium introduced into the glass is present as colloid, the major portion having formed selenides or other selenium compounds, or volatilized. The

[19]Trans. Am. Ceram. Soc., 16, 547 (1914).
[20]Sprechsaal, 45, 659 (1912); 47, 183 (1914); Chem. Ztg., 36, 1149 (1912); 38, 177 (1914).
[21]Sprechsaal, 47, 444 (1914).
[22]Diss. Würzburg (1920).

writer[23] is of the opinion that selenium is present as colloid, wholly, or in part, while the glass is still comparatively free from color and before reheating. Such glasses at times display opalescence which frequently characterizes the colloidal state. Reheating probably forms selenides or polyselenides and perhaps sulfo-selenium compounds of arsenic, of which $As_2 S_3 Se$ and $As_2 S_2 Se_3$ are red and $As_2 S_2 Se_3$ is black with purplish red color in thin sections. Researches which have been under way for some years by M. H. Bigelow in the author's laboratory may help to settle some of these questions. Another perplexing phase of the problem involves the function of the cadmium sulfide. Again, one must ascertain the function of the zinc oxide. Experiments which the writer conducted about twenty years ago already indicated that when zinc is introduced as sulfide and the cadmium as oxide, the selenium red color does not develop. From the investigations now being made by Bigelow on $Na_2 O$: ZnO:$4SiO_2$ glass we can say that selenium is better than sodium selenite; $As_2 O_3$ better than $Sb_2 O_3$: sulfur better than carbon in most cases; and that with niter no color results even on reheating the glass. In these small-scale trials the red color has rarely resulted with less than 1.0 per cent of selenium, but on a large commercial scale 0.5 to 0.8 will suffice. Although our knowledge of the chemistry of selenium glass is very limited, it is nevertheless apparent that composition and heat treatment are important factors in the color production. One of its phases is treated by J. S. Gibson,[24] who mentions variations from orange to red with increasing heat treatment. Heat treatment for pressed blown ware is discussed by F. A. Kirkpatrick and E. H. Roberts.[25] Another discussion by F. Späte[26] states that the tendency toward brown increases with particle size and is presumably retarded by arsenious oxide.

Continuing with the discussion of conditions, K. Fuwa[27] states that in sodium glasses the red color approaches brown and in potassium glasses shades toward the pink. Fuwa states that boric oxide enhances the tendency toward pink and red, while potassium nitrate and arsenious oxide repress it. If the metallic oxides are those of bivalent metals, the color becomes darker, although alkaline-earth oxides have no influence.

It would hardly seem right to close this portion of the discussion without referring to an article by the late J. B. Krak[28] as the result of experiments in which he tried to settle the controversy regarding the use of selenium and selenites. Krak found that whether selenium was introduced into the batches as element or as the selenites of sodium or barium, a glass of a given color intensity contained the same amount of element in each case. He therefore concluded that there was no advantage in using the more expensive salts instead of the element.

Orange, Pink and Amber Glasses

The preceding reference to Fuwa now leads us to the consideration of other colors produced by selenium. Conditions are still a factor if we include composition of the batch under this heading.

Pink glasses are produced from potash-lime batches which contain 0.1 to 0.3 per cent selenium, arsenious oxide and niter. The batch must be practically free from iron. Soda may partly replace the potash, though the color is richer with the higher potash compound. These are true pinks.

Orange glasses have been produced by the writer by adding 0.3 to 0.5 per cent selenium with cadmium sulfide to an ordinary soda-lime batch. Various reducing agents may be employed, of which charcoal is the best.

Amber glasses have also been produced by the writer by adding 0.4 to 0.6 per cent selenium to flint batches in the presence of arsenious oxide and niter.

Selenium As a Decolorizer

Some mention has already been made in the section on arsenic regarding its use in glass where selenium is employed as a decolorizer. Most of the important work which has been published in this field is the contribution of W. E. S. Turner[29] and his collaborator, A. Cousen. There is a further discussion by Hodkin and Cousen.[30] These investigators state that up to 0.9 per cent of iron in glass is decolorizable with selenium and that with soda ash batches, 0.0031 per cent of selenium may be employed. They say that 1/30 as much sodium selenite will suffice and that there should be a ratio of 0.00028: 1 for selenium and ferrous oxide to neutralize the color optically. They recommend the use of cobalt oxide with selenium in the ratio of 6:1 in batches free from salt cake but state that when even small quantities of salt cake are employed, more selenium is necessary, though the cobalt oxide may remain the same. They further recommend that 30 to 50 times as much arsenious oxide be introduced as selenium. While the earlier statements of Turner and Hodkin indicate that sodium selenite is far superior to selenium, the textbook by Hodkin and Cousen, which appeared several years later, claims that 2½ parts by weight of sodium selenite must replace one of selenium when substituted as a decolorizer. In this later work they also intimate that 0.0015 to 0.003 per cent of the sand content should suffice for the weight of selenium employed. This is in keeping with the amount 0.0019 per cent recommended by R. L. Frink[31] for salt-cake-free soda lime batches in tanks with a sand containing 0.08 per cent Fe_2O_3 and a melting rate of 10.5 pounds of glass per square foot (51.4 kg. per sq. m.) per hour. Frink has also experimented extensively on decolorizers. It is interesting to note that while Turner and his associates use arsenious oxide, this is omitted from Frink's tank batch. Turner's group calls attention to a deepening of tint at temperatures from 525° to 550° C. for the bottle glasses reported in the earlier Journal article, further stating that at higher or lower temperatures, no distinct color change was observed. In the second article cited, they state that soda ash batches containing sodium nitrate developed a yellow to a brown color when the glass was maintained for a considerable period at temperatures be-

[23] J. Ind. Eng. Chem. 9, 33 (1917); J. Am. Ceram. Soc., 11, 81 (1928); Colloid Chemistry, Theoretical and Applied, III, 283, New York (1931).
[24] Phys. Rev. (2), 7, 194 (1916).
[25] J. Am. Ceram. Soc., 2, 895 (1919).
[26] Weisz, Hohl und Geräteglas, Leipzig (1931).
[27] J. Japan. Ceram. Soc., 32, 327 (1924).
[28] Glass Ind., 8, 181 (1929).
[29] J. Soc. Glass Tech., 6, 168 (1922); 7, 309 (1923); 9, 111 (1925).
[30] Textbook of Glass Technology, 133, London (1925).
[31] Nat. Glass Budget, June 26, p. 24 (1920).

tween 1,300° and 1,380° C. In batches containing salt cake, the color changes from yellow or pink to green. Here also the statement is made that with glasses containing as much as 1 per cent of boric oxide, there is no appreciable effect upon the amount of selenium required or upon the color of the glass compared with pure soda ash batches. The introduction of 1.5 parts of arsenious oxide per thousand of sand prevented the yellow to brown color previously mentioned and this is cited in favor of the stabilizing action of arsenious oxide in selenium decolorization. Analyses of their glasses indicated a large selenium loss by volatilization, only 23 per cent of the original amount remaining, and that selenium remains as such in the glass and is not oxidized to selenite. In their third paper they claim that discoloration results through heat treatment at 500° to 625° C. only when a very definite tint already exists in the glass before heat treatment. Glasses which were colorless initially remained colorless. Those which were pink either became colorless or developed a slight yellow color. In this paper they also report the effects of solarization on glasses exposed for about thirteen months. This effect was the reverse of that observed in heat treatment. Glasses which were initially yellow became paler, while those which were colorless or slightly pink developed a yellow tint.

And now a final reference to a statement of F. Späte,[26] who gives various formulas for decolorizers on page 34 of his book, some containing arsenic or selenium or both, either alone or with manganese dioxide. He even employs selenium as a decolorizer for lead glasses. His clear insight into the problem which confronts us in selecting the proper decolorizers is shown by his quoting E. Zschimmer[32] to this effect: "The best decolorizing is the satisfying of the iron" and this must be studied for each batch and furnace condition.

Tellurium

In June of 1911, the writer prepared a number of tellurium glasses in which cadmium sulfide, antimony trioxide and tartaric acid were a part of the batch, together with the elementary tellurium. These were zinc glasses of the type commonly employed in making selenium ruby. The purpose in making these trials lay in the fact that a red brown color resulted with sulfur and red with selenium and, according to its position in the Periodic Table, a deeper related color should have resulted with tellurium. Investigation was further prompted by the fact that sulfur boils at 444.6° C.; selenium at 688° C. and tellurium at 1,390° C.; and that losses due to volatilization were high in the sulfur and selenium glasses. In lime glasses 0.6 per cent of tellurium in the batch produced a colorless glass and with 0.9 per cent the glass was yellow. In zinc glasses the latter quantity produced a glass which ranged from yellow to pale green. Unfortunately the experiments had to be discontinued and have never been resumed. In 1914, P. Fenaroli[33] stated that tellurium acts as a coloring agent in glass only under reducing conditions, as a colloid, causing blue or brown colorations or as a polytelluride yielding a red glass. Fenaroli claims that members of the sulfur family have coloring power, which ranges from yellow to red with increasing atomic weight; that they form colloidal suspensions in the glass, the tendency increasing with atomic weight. He found the analogy between selenium and tellurium greater than that between sulfur and either of the others and that none of these substances colored glass under oxidizing conditions. This, of course, has since been contradicted through the production of selenium pink. In 1915, Fenaroli[34] reported another series of investigations in extremely alkaline glasses where, under reducing conditions, polytellurides gave colors approximately the same as they would have in equeous solutions. He reported that the glasses were optically empty, in other words that there were no colloids. In borax or more acid glasses, he obtained a blue tellurium glass, stating that with glasses of high viscosity, the color corresponded to that of sub-microns or colloidal particles rather than tellurides. The writer still hopes to continue his researches on tellurium glasses, feeling that they should find application in the production of desirable colors on a commercial scale. As selenium forms a series of arseno-sulfur compounds, so it may develop that tellurium will do likewise, forming either arseno-sulfur or arseno-selenium combinations which may be utilized. This investigation will be included with one at present under way on selenium glasses in this laboratory.

[32] Sprechsaal, 58, 868 (1925).
[33] Chem. Ztg., 38, 873 (1914).
[34] Kolloid Z., 16, 53 (1915).

A Study of Pulsating Feeders for Molten Glass

By ROY E. SWAIN[1]

(Concluded)

A NUMBER of forming machines of the continuous type have been devised and special apparatus has been necessary to feed the glass to these moving molds. An example of these is shown in Fig. 25.

This drawing is taken from U. S. patent No. 1,314,691 to Ralph Netter. Skid pivots about axis of mold table.

Other methods of feeding glass to molds on continuously moving tables are shown in the following: from U. S. patent No. 1,356,174 to L. D. Soubier. Cup swinging on pivot on the side of the table. From U. S. patent No. 1,416,725 to Richard La France. Funnel travels over mold for a short distance. From U. S. patent No. 1,494,438 to Wm. J. Miller. Mold lags at charging station. From U. S. patent No. 1,599,790 to C. H. Rankin. Feeding glass to moving molds by means of a punty traveling with the mold. From U. S. patent No. 1,618,290 to Richard La France. Pot travels with molds while discharging glass. From U. S. patent No. 1,623,362 to John F. Rule. Guiding glass into continuously moving molds.

The glass below the orifice is constantly changing shape and a slight variation in conditions may destroy the shape

[1] Bethel Engineering Company, Huntington, Col.

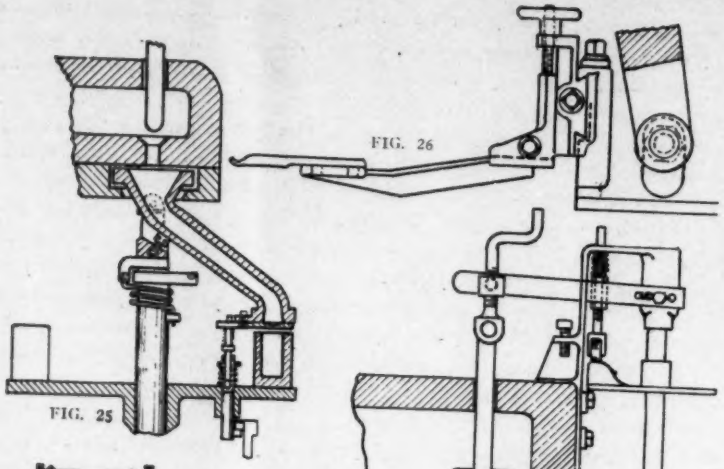

FIG. 26

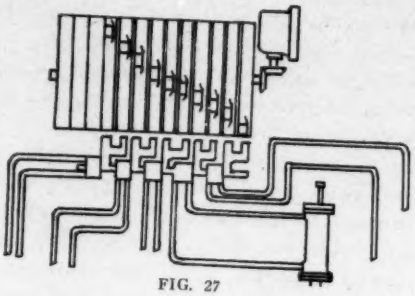

FIG. 27

FIG. 25

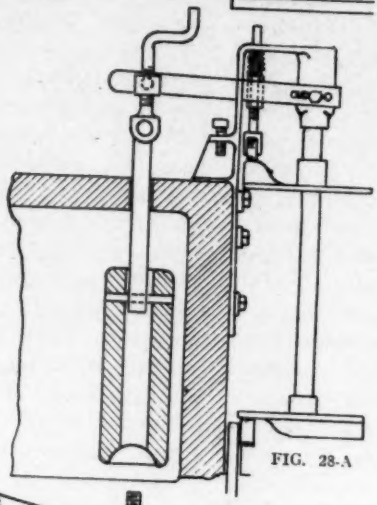

FIG. 28-A

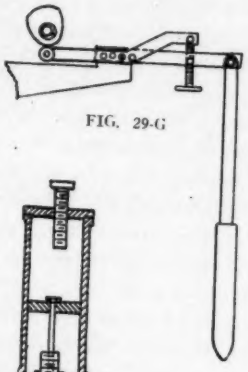

FIG. 29-G

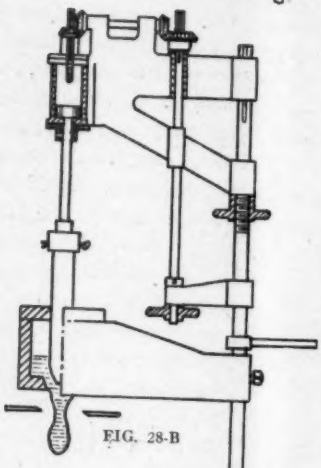

FIG. 28-B

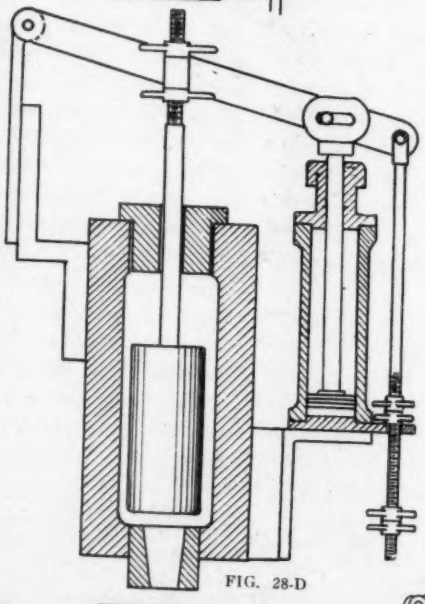

FIG. 28-D

FIG. 29-J

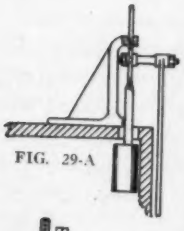

FIG. 29-A

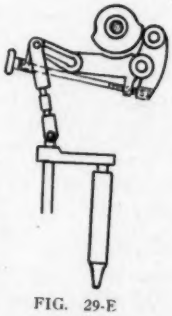

FIG. 29-E

FIG. 29-B

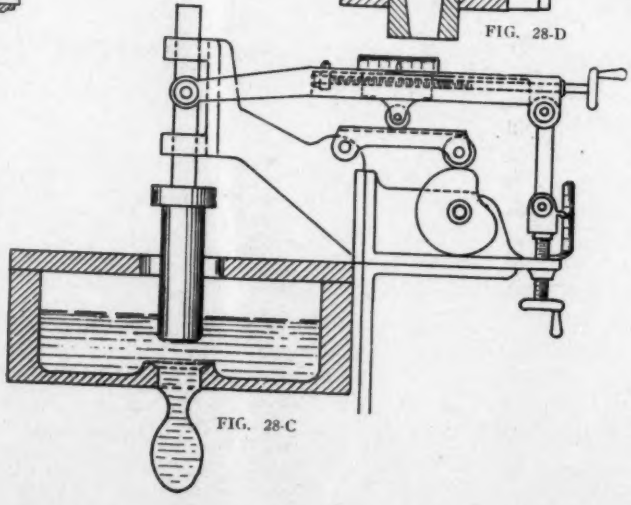

FIG. 28-C

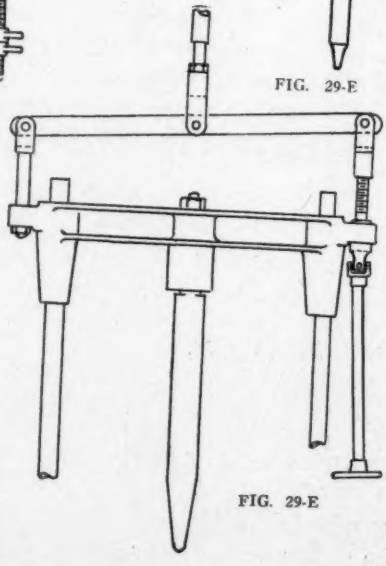

FIG. 29-E

of the gob. To keep a feeder working and producing acceptable gobs a great many adjustments have been devised. A feeder may be required to deliver from 10 or 12 up to 60 or 75 gobs per minute. The weight requirements of these gobs may range from one ounce up to several pounds and the shape required may vary from the ball shape to the plumb gob or the long cylindrical shaped gob. To meet these requirements demands considerable skill of the operator and a very flexible feeder. The most important adjustment or control is in the heating of the forehearth, for by this control corrections in the temperature of the glass must be made to condition it for the work in hand and also corrections made for changes in the nature or working character of the glass. The placing of the burners or other heating elements, insulation layouts, and even cooling means have been the subject of considerable thought and experimenting, but sensitive burners properly placed and well regulated provide the most common temperature regulation.

The size of the orifice must vary with gobs of different shapes or weights and in some cases where the requirements are very exacting the bushings are machined to size.

The operator will have occasions for making many adjustments on the shears even after the thickness, shape and closing speed have been decided upon. The distance between the orifice and the shears will vary when making gobs of different weights and shapes. An example of vertical adjustment is given in Fig. 26 from U. S. patent No. 1,631,107 to Karl E. Peiler. These shears are adjustable in three ways, vertical or back and forth, and also right and left in the horizontal plane.

The closing speed of the shear should be adjustable as a great deal depends upon the speed of the shears in the shaping of the gob. Cutting as the needle recedes, a quick cut will product a blunt end while a slow cut will produce a sharp point on the depending bit of glass. This adjustment is easily made on an air-operated shear but requires a change in the face of the cam on cam operated shears.

The shears may be without timing adjustment (as the movement of the molds are usually synchronized with the closing of the shears) and other operations of the feeder timed to them. The timing of the air-operated shears is quite simple as the different operations are controlled by means of a number of cam dogs on a shaft having a variable speed drive, such as shown in Fig. 27 from U. S. patent No. 1,651,636 to Wm. J. Miller. More elaborate timing mechanisms have each separate cam controlled by means of differentials mounted on the cam shaft. By means of these, delicate adjustments may be made without interfering with the continuous operation of the machine. The Rankin and Tucker, Reeves and Beatty feeders are timed by means of the differential adjusted timing cams. On the air-driven machines these dogs or cams operate the bleeders and valves that control the cylinders which by means of cushion valves, etc., are capable of almost any action.

There are many adjustments desired on the needle, the most important of these being the length of stroke, height above orifice and character of movement.

Means of adjusting the length of the needle stroke are shown in Fig. 28:

(A) from U. S. patent No. 1,462,491 to Wm. J. Miller. Cam-operated needle with means of changing length of one leg of walking beam to adjust length of stroke. U. S. patent No. 1,618,271 shows a similar arrangement.

(B) from U. S. patent No. 1,542,013 to Thomas Stenhouse. Screw in plunger head adjusts length of plunger stroke in needle operating cylinder.

(C) from U. S. patent No. 1,573,742 to Karl E. Peiler and U. S. patent No. 1,582,725. Bethel and Williams.

(D) from U. S. patent No. 1,621,426 to Wm. J. Miller.

The clay needles vary in length unless carefully made and in use they wear away as also do the clay bushings. The condition of the glass changes frequently. All these make the adjustment of the height of the needle in relation to the orifice desirable. Raising or lowering the needle to make weight correction necessitated by changes in the temperature or nature of the glass should only be used to obtain temporary relief and as soon as a temperature regulation can become effective the needle should be returned to its proper setting. Needle height adjustments are shown in Fig. 29:

(A) from U. S. patent No. 810,167 to W. D. Morrison. Slot in needle shaft permits the raising and lowering of the needle on the pitman bearing.

[See Fig. 28 (A)] from U. S. patent No. 1,462,491.

(B) from U. S. patent No. 1,491,067 to John Rau. Threaded shaft with lock nut.

[See Fig. 28 (B)] from U. S. patent No. 1,542,013 to Thomas Stenhouse. Entire mechanism lifted by means of a nut and a screw.

(C) from U. S. patent No. 1,573,742 to Karl E. Peiler.

[See Fig. 28 (C)] from U. S. patent No. 1,582,725 to Bethel and Williams.

(D) from U. S. patent No. 1,618,313 to L. D. Soubier. From U. S. patent No. 1,621,426 to Wm. J. Miller.

(E) from U. S. patent No. 1,626,705 to L. D. Soubier.

The character of the stroke is also very important as upon this depends to a great extent the ability to give the gob the desired shape and temperature distribution. Should the needle be given a uniform movement the finish of the down stroke and the start of the upward stroke would be more effective than the remaining portions of the strokes, for the farther the needle is from the orifice the less action it has upon the depending glass. Should it be desirable to withdraw the stub of glass slowly into the orifice it is necessary to give the needle an accelerated upward movement. Should it be desirable to give the gob a cold tip, the needle is lifted quickly while cutting, then so slowly that the stub is not lifted but merely retarded. The needle stroke for any gob within reasonable limits can be studied out with very little trouble. However the needle stroke is but one of several adjustments and may be made ineffective by the height of the needle above the orifice the temperature of the glass, the distance of the shears from the orifice, the timing of the shears, the cutting speed of the shears, etc.

In selecting or designing a feeder one should consider all that is desirable in such a machine and strive to attain the maximum of desirability with a minimum of complication.

Taken as a whole the feeder should have the following:

Variable speed drive or timing arrangement.

Clearance for forming machine so that glass goes directly into mold.

Bearings and wearing parts protected from heat.

Flexibility, easy replacements of parts and adjustable timing of different functions.

If the feeder is not attached to the forehearth it should be so mounted that it may be moved easily to follow the forehearth as it may move under the influence of heat.

The forehearth should have the following specifications:

Large enough to condition glass.

Deep enough not to be affected by the usual variations in tank levels.

Heating units properly placed.

Insulated.

Built as far as possible of standard shapes.

Bushing in orifice consisting of a master bushing and a secondary bushing easily accessible for quick changing.

Skimmer to prevent floating stones, etc., from entering the flow.

Baffle to protect glass from irregularity of heat caused by changing fires in a regenerative furnace, and conserve the heat of the forehearth burners.

Means of stirring glass to break up cords, cold streaks, etc.

Opening through which it may be cleaned.

Stack for burned gases.

Gate or valve for closing off from tank to make repairs, etc.

SPECIFICATIONS FOR SHEARS:

Co-acting.

Thin blades, U, V, or parabolic in shape.

Adjustable tension on blades.

Means for cooling and lubricating.

Cutting clearance on blades.

Self-aligning of blades.

Right and left adjustment of blades.

Back and forth adjustment of blades.

Vertical adjustment of blades.

Timing adjustment of shears in relation to other operations of feeder or forming machine.

Control of closing speed of shears.

Adjustable baffle on upper blade to prevent lower blade throwing upper end of gob.

Easy to change.

Easy to sharpen.

Means of making inoperative without disturbing the remainder of the machine.

Means of opening shears when power is off.

A yielding cutting force.

PULSATIONS (NEEDLE) SPECIFICATIONS:

Variable length of stroke. (At will of operator.)

Variable height of needle in relation to orifice. (At will of operator.)

Variable character of needle movement.

Variable timing in relation to other operations of the feeder.

Means of throwing out of action without disturbing remainder of machine.

Easily replaced.

Easily centered in bushing. (Clay parts warp in drying and burning but if the needle is held on a core the overhang is reduced to a point where the warping will cause no serious consequence).

Needle operated by a yielding force to prevent undue strain in stiff glass or when obstructions are encountered.

The stirring device should be simple, sturdy and the clay parts easily replaced.

The Manufacture of Rolled Plate

By ERNST LUTZ*

(*Continued from the July, 1932, issue*)

FIG. 244 shows diagrammatically the lay-out of the Ford Plate Glass Factory in River Rouge. There are 4 tank furnaces each of about 78′ overall length and 16′ width. They taper to a 6′ radius at the spout end and are set 50′ apart: 3 furnaces are continuously in commission and one is standing by, or is under repair. The capacity of a tank furnace is about 400 tons metric (440 short tons); this capacity should enable the furnace to deliver within 24 hours up to 30 tons (33 short tons) of glass ready to be rolled. With each furnace is coordinated a mill, a lehr of 442′ length and a continuous grinding and polishing plant, the working tables of which move on endless rails alongside the lehr; see also Figs. 129, 130 and 131. The succession in which the various working processes take place is as has already been described and is also evident from the illustration. According to the journal, THE GLASS INDUSTRY, No. 7 of July, 1924, the output of one furnace is about 7 sq. ft. every minute, which, allowing for breakage, corresponds to a velocity of the ribbon of 34-36″ per minute and of a daily output of approximately 15,000 sq. ft. of rough glass. If the annealing channel is 442 ft. long, the annealing process takes from 2¼ to 2½ hours. At the beginning of the lehr the temperature should be about 1075° F. and at its end about 80° F. In the furnace itself the glass ready for flowing out has a temperature of about 2000° F., in the feeder a, it is further heater to 2150° F. The batches fed into each furnace are made up of the following proportions:

Sand	lbs. 438 to 444
Limestone	lbs. 112 to 128
Soda Ash	lbs. 131 to 140
Salt Cake	lbs. 24.5 to 29.5
Charcoal	oz. 1.25 to 1.40
Arsenic	oz. 1.50 to 2.11
Cullet	lbs. 155 to 50

As the ribbon of glass emerges from the lehr it is cut by

* Of Dessau, Germany. This work is appearing in German in the new edition of *Dralle-Keppeler*, "Die Glasfabrikation."

FOOTNOTE: In the Figures, originally prepared for use eventually in the new edition in the German language of *Dralle-Keppeler*, "Die Glasfabrikation" in 1931, dimensions are given in metres (*m*) and millimetres (*mm*). We would like to have given these in feet and inches but the translation and the making of nearly two hundred and fifty new illustrations would have involved a prohibitive loss of time and expense. To some of our readers the metric system is as familiar as the English units; for the others we may say that a metre is approximately 40 inches, and a millimetre is approximately 1/25 of an inch. A thousand millimetres, of course, go to a metre.—F. W. P.

hand into section of 9'5" length, corresponding to the size of the grinding tables. Each sheet contains glass for 3 complete Ford windshields. Each of the lehrs is operated by two 10 HP. electric motors. For each unit 86 grinders are

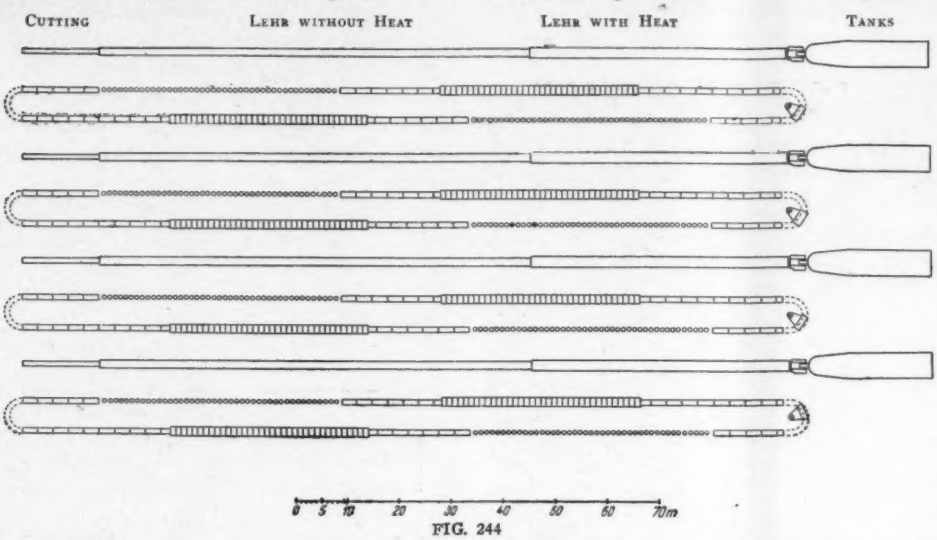

FIG. 244

provided, i.e., 43 for each surface, and 72 polishers, i.e., 36 per side. Fig. 245 is taken from the book "Ford Betriebe und Ford Methoden" by Paul Rieppel, published by Oldenburg, Munich. At the left hand side the lehr may be noticed; beside it and in the background a grinder can be

FIG. 245

seen. In the foreground at the right hand side the turning arrangement, also indicated in the illustration 244, is visible which moves the tables over to the grinding and polishing machinery. (Furthermore this is referred to in C. W. Avery's report in THE GLASS INDUSTRY, April 4, 1930, pages 75-78.)

The final utilization of this flowing method for the certain obtaining of a good plate glass quality depends, as pointed out before, not only on a perfect command over the tank furnace but also—and this first of all—on the manner in which the glass mass flows out of the tank and is directed into the rolling machine. Even if the glass mass gets perfectly well to the flow spout of the tank, there is still the great danger that the issuing glass stream may entrap bubbles or develop strings. The higher the temperature of the glass, that is the weaker it is, the faster it runs out, the more difficult will be the regulation of the stream and its spreading out in the machine, and the greater will be the danger that bubbles may come in and combustible particles such as dust and others may spoil the purity.

On the other hand, if the temperature is too low and the glass mass consequently too stiff, the danger arises that strings may be formed and that fire cracks may show up on the outside. Also the evenness of the surfaces of the glass ribbon and the uniformity of its thickness depend tc a great

extent on the temperature of the glass and on the revolving velocity of the rolls which must be adjusted to suit the temperature of the glass. A faultless evenness of the plates is obtained by the Bicheroux rolling machine since both rolls are rippled. It is said however, that the rippling on both sides means lost glass, requires more grinding and renders

FIG. 246

the exact cutting of the cold rough glass sheets more difficult. However, that portion of the glass mass that sticks in the rippling is very small and the grinding work necessary for its removal is just a trifle compared with the work necessary to grind off other inequalities which arise from smooth

FIG. 247

rolls. The rippling may also be a hindrance as far as the cutting of the cold glass plates is concerned, but they are so flat that without endangering the plates the cut can be executed with sufficient safety. The thinner the rough glass sheet is rolled out, the larger is its surface in proportion to the quantity of glass used and the greater is the rôle played by the glass that gets into the rippling, since the thinner the glass is rolled out the deeper must be the rippling to be effective. This and the quick wear of the rippling of the rolls as well as the fear that dirt may get from the rippling into the glass explains perhaps the desire to get along without them.

The efforts directed towards greater safety in obtaining glass of highest quality by means of the flowing method has produced various suggestions and constructions of flowing devices and rolling machines. Only a few of them can be considered here. Some have the glass, as in the Ford method, flow in a narrow and thick stream into the rolling machine; others start from exactly the opposite condition and have the glass spread out to a thin ribbon-like stream before it gets into the machine. In some the level of the glass which runs to the rolls is the same as the level of the glass body in the furnace; in others it is below.

FIG. 248

According to U. S. patent 1772072 of John L. Drake. Assignor to the Libbey-Owens-Ford Glass Company of Toledo, Ohio (Figs. 250-253), a relatively thick, narrow stream of molten glass flows into the rolling machine. In order to ease the spreading of this thick stream and to perform it more gradually, several pairs of forming rolls are arranged; the figures for instance show 4 pairs. The rolls of the first three pairs are formed like double cones, i.e., they taper from their centers towards their two ends. The degree of taper of the several pairs of rolls decreases from the first pair to the third pair while the fourth and last pair is made up of cylindrical rolls to give the hot glass sheet its straight and final form.

This arrangement indeed permits a very careful treatment of the glass stream during the rolling act. As the glass stream is spread out gradually, the rolling can be executed

with an increased speed without the need of an excessive increase of the temperature of the glass. The relatively low temperature lessens the danger of inclosing bubbles while on the other hand there need to be no fear that strings may be formed since the glass is spread out gradually. The higher speed of the rolling is at the same time favorable to the evenness of the glass sheet, because it shortens the period of its contact with the last pair of rolls and the sheet, after it obtains its final thickness, gets more quickly into the lehr. Between the first pairs of rolls the glass is still relatively

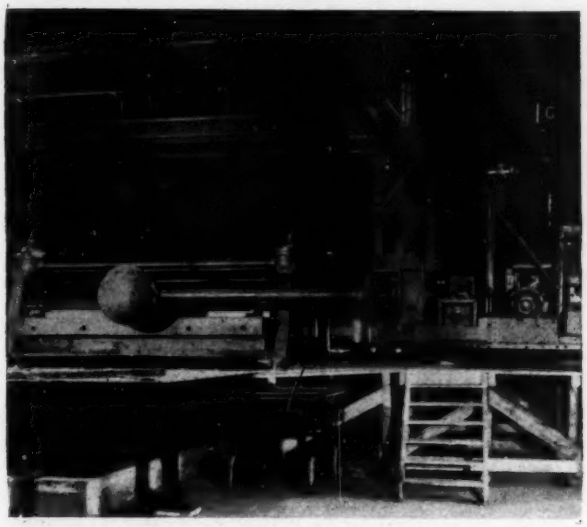

FIG. 249

thick; this means that its innermost parts can still deliver heat to the outside parts which are in contact with the rolls. The outside of the glass ribbon must by all means be soft when it passes the last pair of rolls and the curve leading to the lehr; for this reason there must be some

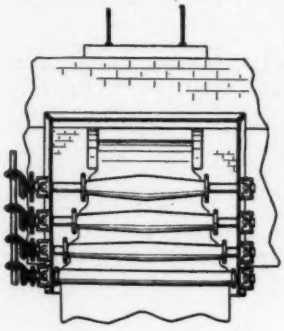

FIG. 250

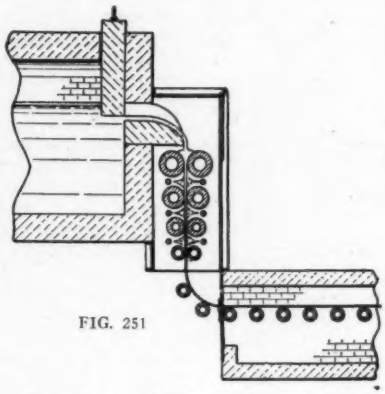

FIG. 251

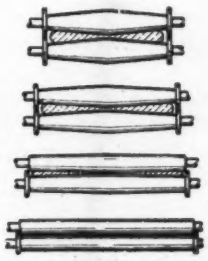

FIG. 252

FIG. 253

arrangement to heat it again. As shown by Fig. 251, burners are installed on both sides intermediate two pairs of rolls. The flow spout of the furnace and the whole rolling machine are enclosed by an insulated casing.

Although the tapered rolls warp but little because they are in constant rotation, and even if it would be of no influence on the final thickness of the sheet, the rolls must not get so hot that the glass sticks to them and their gearing is endangered. This must especially be considered for the uppermost pair of rolls. Therefore, an effective air or water cooling must be provided. The greatest influence on the evenness and the final thickness of the glass sheet is exerted, of course, by the last pair of rolls which must be protected against any warping whatever.

In order to prevent damming up or bending of the glass sheet in the rolling machine, each of the last three pairs of rolls should be driven a little faster than corresponds with the proper speed on that respective point; this causes a slight tension of the sheet rather than damming up. The pairs of rolls must be driven at progressively increasing speeds anyway, for each succeeding pair has to roll out a greater length of the glass ribbon than the preceding because the glass becomes thinner between each pair of rolls. The circumferential velocity may even be set a little beyond this to exclude the least danger of damming up.

The driving and the mounting of the rolls may be seen from Figures 250 and 253; they are much alike to those of Fourcault-drawing machines. The quantity of the issuing glass should be regulated, as is done by the Ford Motor Company by a gate which is built into the front of the furnace and dips into the mass of molten glass.

Figs. 254-256 represent a device according to U. S. patent 1749332 of Nicklas Franzen, assignor to the Mississippi Glass Company of New York. Here, too, the glass flows out at points below the level of the molten glass mass in the furnace. However, the flow of the glass is divided into smaller streams by the arrangement of several openings 13 in the front of the furnace (in the figures three openings are shown). The three openings 13 lead to the three flow spouts 14 out of which the three streams flow into the funnel 16 which is made of fire-proof material and ends in the angle between top roll and lower roll close to the big lower roll. The lower and narrower opening of this funnel is already about as wide as the sheet is going to be. Hence, all the rolling machine has to do, is to confer on the sheet the final width and thickness and, of course, the proper evenness, and to convey it to the lehr.

Here as in the device described first the aim is to avoid reducing a thick stream of molten glass by the rolls to the dimensions of the sheet all at once. This latter patent claims also that it prevents the admission of bubbles and permits the rolls to be driven quicker. The volume of the issuing glass is controlled by the closure members 20 which dip into the flow spouts 14.

(To be continued)

Glass Industry

ESTABLISHED 1920

The First Trade Journal Devoted Primarily to Glass Technology, Engineering, Raw Materials and Glass Factory Equipment and Operation

PUBLISHED MONTHLY

Copyright, 1932 by

GLASS INDUSTRY PUBLISHING COMPANY, INC.

24 West 40th Street, New York

Telephone CHickering 4—2354 Cable Address Glasdustry

G. W. Cooper, Managing Editor

Subscription Price..United States $2.00 a Year; Foreign $3.00
Single Copy .....25 Cents

Vol. 13 AUGUST, 1932 No. 8

CONTENTS

	Page
Use of Electrochemical By-Products in Glass Making	129
A Study of Pulsating Feeders for Molten Glass (Concluded)	133
The Manufacture of Rolled Plate (Continued)	136
Maker of Auto Held Liable for Injury by Glass	140
Recent Patents	142
Owens-Illinois Earnings	143
Polished Plate Glass in June	143
Hazel-Atlas, Hartford-Empire Litigation Settled	143
Brossard Back on Tariff Commission	143
New President for American Flint Glass Union	143
Current Prices of Glass-Making Materials	144
Monthly Summary of U. S. Foreign Trade in Glass	144

CLASSIFIED BUYERS' GUIDE, PAGE 8
INDEX TO ADVERTISEMENTS, PAGE 9

Reference to the contents of earlier issues of THE GLASS INDUSTRY can be found in THE INDUSTRIAL ARTS INDEX in many Public and Technical Libraries.

Maker of Auto Held Liable for Injury by Glass

Representation Windshield Was Shatter-proof Ruled Actionable as to Buyer From Automobile Dealer

[Decision of Washington Supreme Court, Olympia, Wash., on Appeal from the Superior Court for Lewis County. No. 23749 Sam Baxter vs. Ford Motor Company et al.]

(*Reprinted from United States Daily, July* 16, 1932)

OPINION OF THE COURT

June 30, 1932

HERMAN, J.—During the month of May, 1930, plaintiff purchased a Model A Ford town sedan from defendant St. John Motors, a Ford dealer, who had acquired the automobile in question by purchase from defendant Ford Motor Company. Plaintiff claims that representations were made to him by both defendants that the windshield of the automobile was made of non-shatterable glass which would not break, fly or shatter.

October 12, 1930, while plaintiff was driving the automobile through Snoqualmie pass, a pebble from a passing car struck the windshield of the car in question, causing a small piece of glass to fly into plaintiff's left eye, resulting in the loss thereof. Plaintiff brought this action for damages for the loss of his left eye, and for injuries to the sight of his right eye. The case came on for trial, and, at the conclusion of plaintiff's testimony, the court took the case from the jury and entered judgment for both defendants. From that judgment plaintiff appeals.

Appellant's first assignment of error is: The court erred in allowing the respondents to introduce in evidence, over the objection of appellant, the written contract of agency between the respondents. An investigation of the record discloses that A. C. St. John, the president of St. John Motors, was called as a witness by appellant's counsel, and was questioned with reference to his relationship with respondent Ford Motor Company. On cross-examination by counsel for the Ford Motor Company, this contract was offered in evidence for the purpose of showing the relations between respondents. The ruling was correct.

The second assignment of error is that the court refused to admit in evidence certain catalogues and printed matter furnished by respondent Ford Motor Company to respondent St. John Motors for distribution and assistance in sales.

When the car was sold to appellant, a written purchase order was entered into between the seller and the purchaser. Ford Motor Company was not a party to this agreement. Certain reading matter was printed on the back of the purchase contract, which printing purported to tell what constituted the Lincoln Motor Company warranty and the Ford Motor Company warranty. There was nothing in connection with the sales agreement which indicates that either the Lincoln Motor Company warranty or the Ford Motor Company warranty there set forth was made to, or accepted by, appellant or any other person.

* * *

The instrument in question was devoid of any provision which would have given appellant the right to sue the Lincoln Motor Company or the Ford Motor Company, if privity of contract be a condition precedent to a suit predicated on misrepresentations perpetrated by a manufacturer upon the public, resulting in the sale of products put forth as possessing qualities which the victim of such misrepresentations later discovers, to his damage, were lacking. Hence, respondent Ford Motor Company cannot successfully maintain that, so far as appellant is concerned, its warranties to appellant were set forth in the purchase agreement between appellant and the respondent dealer.

So far as that respondent, St. John Motors, is concerned, the written contract limits its responsibility to appellant. The purchase order stated that it contained the entire contract, and there was contained therein the following statement:

"It is further agreed that no warranty either express or implied is made by the dealer under this order or otherwise covering said car."

* * *

To have permitted the introduction of the testimony in question as against respondent St. John Motors, would have been to have countenanced an attempt to vary the terms of the written instrument by parol testimony. Such evidence was not competent against respondent St. John Motors, and there was not sufficient evidence against that respondent to justify submission of the cause to the jury. Judgment was properly entered for respondent St. John Motors.

The principal question in this case is whether the trial court erred in refusing to admit in evidence, as against respondent Ford Motor Company, the catalogues and printed matter furnished by that respondent to respondent St. John Motors to be distributed for sales assistance. Contained in such printed matter were statements which appellant maintains constituted representations or warranties with reference to the nature of the glass used in the windshield of the car purchased by appellant.

* * *

A typical statement, as it appears in appellant's exhibit for identification No. 1, is here set forth:

"Triplex Shatter-Proof Glass Windshield. All of the new Ford cars have a Triplex shatter-proof glass windshield—so made that it will not fly or shatter under the hardest impact. This is an important safety factor because it eliminates the dangers of flying glass—the cause of most of the injuries in automobile accidents. In these days of crowded, heavy traffic, the use of this Triplex glass is an absolute necessity. Its extra margin of safety is something that every motorist should look for in the purchase of a car—especially where there are women and children."

Respondent Ford Motor Company contends that there can be no implied or express warranty without privity of contract, and warranties as to personal property do not attach themselves to, and run with, the article sold.

Mazetti v. Armour & Co., 75 Wash. 622, 135 Pac. 633, Ann. Cas. 1915C 140, 48 L. R. A. (N. S.) 213, was a case brought against Armour & Co. by proprietors of a restaurant. The complaint alleged that, in the course of their business they purchased from the Seattle Grocery Company a carton of cooked tongue, relying upon the representations of Armour & Co., that its goods were pure, wholesome and fit food for human beings; that, in the center the carton, was a foul, filthy, nauseating and poisonous substance; that, during the due course of trade, plaintiffs served one of their patrons a portion of the tongue, the customer ate of it, became sick and nauseated, and proceeded publicly to denounce service of such foul and poisonous food; that the incident became generally known; that plaintiff had no knowledge of or means of learning the character of the food served, that its condition could not be discovered until it was served for use; and that, as a result thereof, plaintiffs were damaged. The trial court sustained a demurrer to the complaint. In the course of an opinion reversing the case, the court said:

"It has been accepted as a general rule that a manufacturer is not liable to any person other than his immediate vendee; that the action is necessarily one upon an implied or express warranty; and that without privity of contract no suit can be maintained; that each purchaser must resort to his immediate vendor. To this rule, certain exceptions have been recognized;

"(1) Where the thing causing the injury is of a noxious or dangerous kind; (2) where the defendant has been guilty of fraud or deceit in passing off the article; (3) where the defendant has been negligent in some respect with reference to the sale or construction of a thing not imminently dangerous. . . .

* * *

"Although the cases differ in their reasoning, all agree that there is a liability in such cases irrespective of any privity of contract in the sense of immediate contract between the parties. . . .

"To the old rule that a manufacturer is not liable to third persons who have no contractual relations with him, for negligence in the manufacture of an article, should be added another exception—not one arbitrarily worked by the courts—but arising as did the three to which we have heretofore alluded, from the changing conditions of society.

"An exception to a rule will be declared by courts when the case is not an isolated instance, but general in its character and the existing rule does not square with justice. Under such circumstances, a court will, if free from the restraint of some statute, declare a rule that will meet the full intendment of the law. No case has been cited that is squarely in point with the instant case, but there is enough in the adjudged cases to warrant us in our conclusions. . . .

"We would be disposed to hold on this question that, where sealed packages are put out and it is made to appear that the fault, if any, is that of the manufacturer, the product was intended for the use of all those who handle it in trade as well as those who consume it."

In the case at bar, the automobile was represented by the manufacturer as having a windshield of non-shatterable glass "so made that it will not fly or shatter under the hardest impact." An ordinary person would be unable to discover by the usual and customary examination of the automobile whether glass which would not fly or shatter was used in the windshield.

* * *

In that respect, the purchaser was in position similar to that of the consumer of a wrongly labeled drug, who has bought the same from a retailer, and who has relied upon the manufacturer's representation that the label correctly set forth the contents of the container.

For many years, it has been held that under such circumstances, the manufacturer is liable to the consumer, even though the consumer purchased from a third person the commodity causing the damage. Thomas v. Winchester, 6 N. Y. 397, 57 Am. Dig. Dec. 455.

The rule in such cases does not rest upon contractual obligations, but rather on the principle that the original act of delivering an article is wrong, when, because of the lack of those qualities which the manufacturer represented it as having, the absence of which could not be readily detected by the consumer, the article is not safe for the purpose for which the consumer would ordinarily use it.

The vital principle present in the case of Mazetti v. Armour & Co., supra, confronts us in the case at bar. In the case cited, the court recognized the right of a purchaser to a remedy against the manufacturer because of damages suffered by reason of a failure of goods to comply with the manufacturer's representations as to the existence of qualities which they did not in fact possess, when the absence of such qualities were not readily discoverable, even though there was no privity of contract between the purchaser and the manufacturer.

* * *

Since the rule of caveat emptor was first formulated, vast changes have taken place in the economic structures of the English speaking peoples. Methods of doing business have undergone a great transition. Radio, bill boards and the products of the printing press have become the means of creating a large part of the demand that causes goods to depart from factories to the ultimate consumer.

It would be unjust to recognize a rule that would permit manufacturers of goods to create a demand for their products by representing that they possess qualities which they, in fact, do not possess; and then, because there is no privity of contract existing between the consumer and the manufacturer deny the consumer the right to cover if damages result from the absence, of those qualities, when such absence is not readily noticeable.

"An exception to a rule will be declared by courts when the case is not an isolated instance, but general in its character and the existing rule does not square with justice. Under such circumstances, a court will, if free from the restraint of some statute, declare a rule that will meet the full intendment of the law." Mazetti v. Armour & Co., 75 Wash. 622, 135 Pac. 633.

We hold that the catalogues and printed matter furnished by respondent Ford Motor Company for distribution and assistance in sales (appellant's exhibits for identification Nos. 1, 2, 3, 4, and 5) were improperly excluded from evidence, because they set forth representations by the manufacturer that the windshield of the car which appellant bought contained Triplex non-shatterable glass which would not fly or shatter.

* * *

The nature of non-shatterable glass is such that the falsity of the representations with reference to the glass would not be readily detected by a person of ordinary experience and reasonable prudence. Appellant under the circumstances shown in this case, had the right to rely upon the representations made by respondent Ford Motor Company relative to qualities possessed by its prod-

ucts, even though there was no privity of contract between appellant and respondent Ford Motor Company.

Appellant assigns as error rejection of the following offer to prove:

"We now offer to prove by the witness on the stand that he didn't know anything about shatter-proof glass or any other kind of glass; that he had never been engaged in any occupation which would familiarize him with glass and know at all the difference between shatter-proof glass and any other kind of glass, and didn't know anything different at that time; that he didn't know anything about the composition or otherwise of Triplex shatter-proof windshields or Triplex shatter-proof glass; that he relied solely and wholly upon the representations made by St. John and Johnnie Delaney and what he read and saw in the catalogues from them, which have been offered in evidence; that he believed these representations to be true and by reason of his belief in these representations, and by reason of these representations, he purchased on or about the 13th of May, a Model A Ford town sedan."

* * *

With the exception of so much of the offer as related to the representations of Mr. St. John and Johnnie Delaney (a salesman for respondent St. John Motors), the testimony contemplated by the offer to prove was relevant, and should have been received. While it is a matter of common knowledge that the difference between glass which will not fly or shatter and ordinary glass is not readily noticeable to a person of ordinary experience, nevertheless appellant was entitled to show an absence of familiarity with non-shatterable glass. His testimony would have tended to show that he had no experience which should have enabled him to recognize the glass in the windshield as other than what it was represented to be.

The trial court erred in taking the case from the jury and entering judgment for respondent Ford Motor Company. It was for the jury to determine, under proper instructions, whether the failure of respondent Ford Motor Company to equip the windshield with glass which did not fly or shatter, was the proximate cause of appellant's injury.

We have considered the other assignments of error, and find them to be without merit.

Reversed, with directions to grant a new trial with reference to respondent Ford Motor Company; affirmed as to respondent St. John Motors.

MILLARD, BEALS, and MAIN, JJ., concur.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

MANUFACTURE OF NONSPLINTERING GLASS SHEETS. U. S. 1,867,009. July 12, 1932. George Edward Heyl, Westminster, London, England, assignor to Morris Greenhill, London, England. Original application filed 9/18/28. Divided and this application filed 8/30/30.

METHOD OF MANUFACTURING NONSHATTERABLE GLASS. U. S. 1,867,085. July 12, 1932. Otto S. Marckworth, Columbus, O. Filed 3/7/24.

FEEDER FOR GLASS LEERS. U. S. 1,867,389. July 12, 1932. Julius Sylvester, Washington, Pa., assignor to Simplex Engineering Co. Filed 1/7/31.

METHOD AND APPARATUS FOR GATHERING MOLTEN GLASS IN MOLDS. U. S. 1,867,440. July 12, 1932. Edward G. Bridges, Anderson, Ind., assignor to Lynch Corp. Filed 12/26/29.

MEANS FOR STORING AND SUPPLYING GLASS BATCHES OF UNIFORM MIXTURE. U. S. 1,867,489. July 12, 1932. Robert Bennett and Samuel B. Bowman, Zanesville, O., assignor to Hazel-Atlas Glass Co., Wheeling, W. Va. Filed 4/16/28.

SYSTEM FOR SURFACING GLASS SHEETS. U. S. 1,860,083. 5/24/32. John L. Drake, Toledo, O., assignor to Libbey-Owens-Ford Glass Co., Toledo, O. Filed 6/29/29.

PROCESS AND APPARATUS FOR MAKING SHEET GLASS. U. S. 1,859,862. 5/24/32. Louis Boudin, St. Gobain, France, assignor to Societe Anonyme des Manufactures des Glaces & Produits Chimiques de Saint-Gobain, Chauny & Cirey, Paris, France. Filed 11/4/27 and in France 11/15/26.

APPARATUS FOR FORMING REENFORCED GLASS. U. S. 1,859,880. 5/24/32. Karl Macht, Ober-Salzbrunn, Germany, assignor to Schlesische Spiegelglas Manufactur Carl Tielsch, G. m. b. H., Waldenburg-Altwaser, Germany. Filed 3/6/30.

PROCESS AND APPARATUS FOR PRODUCING SHEET GLASS. U. S. 1,860,085. 5/24/32. John L. Drake, Toledo, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 11/10/30.

SHEET GLASS APPARATUS. U. S. 1,860,100. 5/24/32. Frank J. Kincaid, Charleston, W. Va., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 11/15/30.

PROCESS AND APPARATUS FOR PRODUCING SHEET GLASS. U. S. 1,860,140. 5/24/32. John L. Drake, Toledo, O., assignor to Libbey-Owens-Ford Glass Co., Toledo, O. Filed 1/24/28.

CONTINUOUS GLASS GRINDING AND POLISHING APPARATUS. U. S. 1,862,445. June 7, 1932. Frederic Barnes Waldron, Prescot, England, assignor to Pilkington Brothers, Limited, Liverpool, England. Filed 3/5/31 and in Great Britain 3/18/30.

GLASS CRUMBLING MACHINE. U. S. 1,862,194. June 7, 1932. Joseph J. McCabe, Rochester, N. Y., assignor to Bausch & Lomb Optical Company, Rochester, N. Y. Filed 11/1/28.

METHOD OF AND APPARATUS FOR DRAWING GLASS. U. S. 1,861,761. June 7, 1932. Arthur E. Spinasse, Mount Vernon, Ohio, assignor to Pittsburgh Plate Glass Company. Filed 5/4/22.

METHOD OF PREPARING GLASS PANELS. U. S. 1,861,577. June 7, 1932. Gustave F. Mattman, Cincinnati, O., assignor to The Cincinnati Advertising Products Company, Cincinnati, Ohio. Filed 2/25/30.

APPARATUS FOR MAKING PLATE GLASS. U. S. 1,861,627. June 7, 1932. John H. Fox, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co., Pittsburgh, Pa. Filed 8/15/28.

SAFETY GLASS. U. S. 1,861,915. June 7, 1932. Max Hagedorn and Adolf Jung, Dessau-in-Anhalt, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the Main, Germany. Filed 7/12/29 and in Germany 7/14/28.

GLASS EXTRACTING DEVICE. U. S. 1,862,976. June 14, 1932. John E. Merneck, Hammond, Ind. Filed 12/18/30.

GLASS SEVERING APPARATUS. U. S. 1,862,979. June 14, 1932. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 11/16/28.

FEEDING MOLTEN GLASS. U. S. 1,805,095. June 14, 1932. George W. Batchell, Toledo, Ohio. Filed 11/7/28.

METHOD AND APPARATUS FOR MELTING GLASS. U. S. 1,863,156. June 14, 1932. Robert L. Frink, Lancaster, Ohio. Filed 1/13/27.

METHOD AND APPARATUS FOR FORMING GLASS TUBING FROM GLASS BILLETS. U. S. 1,857,791. May 10, 1932. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 12/11/28.

GLASS CUTTING MACHINE. U. S. 1,857,748. May 10, 1932. John Eugene Walker, Atlanta, Ga., assignor to The Clymer Mfg. Co., Denver, Colo. Filed 6/22/22.

DEVICE FOR MANUFACTURING HOLLOW GLASS BODIES BY MEANS OF PRESSING AND BLOWING. U. S. 1,857,540. May 10, 1932. Jan. Jesaijas Christiaan Hardenberg, Eindhoven, Netherlands, assignor to I. A. Nypels, The Hague, Netherlands. Filed 5/7/28.

METHOD AND MACHINE FOR FORMING GLASS TUBING FROM PRESSED GLASS BLANKS. U. S., 1,857,257. May 10, 1932. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 12/11/28.

APPARATUS FOR MAKING WIRE GLASS. U. S. 1,856,630. May 3, 1932. Paul F. Gutmann, St. Louis, Mo., assignor to Mississippi Glass Company, St. Louis, Mo. Filed 10/9/30.

DEVICE FOR MOUNTING GLASS MIRRORS, ETC. U. S. 1,856,923. May 3, 1932. Harley H. Miller, Middletown, O., assignor to The Miami Cabinet Company, Ohio. Filed 10/15/28.

APPARATUS FOR USE IN THE MANUFACTURE OF GLASSWARE. U. S. 1,858,137. May 10, 1932. Leon Jean Broche, St. Cloud, France, assignor to Tropenas Company, New York. Filed 9/20/28.

GLASS SURFACING APPARATUS. U. S. 1,857,852. May 10, 1932. Joseph M. McGoldbrick, Toledo, O., assignor to Libbey-Owens-Ford Glass Company Toledo, O. Filed 6/18/31.

Owens-Illinois Earnings

Following the directors' meeting of Owens-Illinois Glass Company, held at Toledo, President Wm. E. Levis announced that the regular quarterly dividends have been declared and have been more than earned during the quarter just ended. The dividend declaration was at the regular rate of 50 cents a share on the 922,173 shares of common stock outstanding, payable August 15, 1932, to stockholders of record July 30th, and $1.50 per share on the 80,000 shares of six per cent preferred stock, payable October 1, 1932, to stockholders of record September 15th. The resignation of William Ford as Chairman of the Board was also announced. No successor to Mr. Ford was appointed and he remains as a director.

The net earnings of Owens-Illinois Glass Company and subsidiaries, after depreciation, taxes, debenture interest, and some extraordinary write-offs for the twelve months ended June 30, 1932, were $1,830,228, equivalent after full provision for dividends on the preferred shares to $1.46 per share on the outstanding common stock. During the preceding twelve months ended June 30, 1931, the company's earnings were $2,716,839, or at the annual rate of $2.43 per share on the common stock, after deducting preferred dividend requirements.

Polished Plate Glass in June

The total production of polished plate glass by the member companies of the Plate Glass Manufacturers of America, as reported by Secretary P. A. Hughes for the month of June, 1932, was 4,909,988 sq. ft., as compared to 3,015,943 sq. ft. produced by the same companies in the preceding month, May, 1932, and 6,408,660 sq. ft. produced by the association members in the corresponding month last year, June, 1931.

This makes a total of 29,291,919 sq. ft. produced by these companies during the first six months of 1932, as compared to 46,296,919 sq. ft. produced by the association members during the first six months of 1931, and 30,463,123 sq. ft. produced by them during the last half of that year.

Hazel-Atlas, Hartford-Empire Litigation Settled

The Hazel-Atlas Glass Company and the Hartford-Empire Company announce that they have consummated a settlement of all patent litigation which has existed between the two companies for some years past. The Hazel-Atlas Glass Company has acquired a license from the Hartford-Empire Company to use its inventions in feeders and forming machines, agreeing to pay the Hartford company standard royalty rates.

Brossard Back on Tariff Commission

The re-appointment of Tariff Commissioner Dr. Edgar Bernard Brossard by the President has been confirmed by the Senate. He was a member of the Tariff Commission in 1929 and 1930, of which he was chairman from January, 1930, until its reorganization in September, 1930. The Commission is busy investigating the relation of imports to value of imports.

New President for American Flint Glass Workers' Union

At the annual convention of the American Flint Glass Workers Union in July, M. J. Gillooley, of Toledo, O., was elected president to succeed William P. Clarke, who had occupied the affice for the past 16 years. The vote was 79½ to 67½.

The American Glassware Manufacturers at their annual meeting, Atlantic City, beginning Monday, July 18th, re-elected George Doherty as president. On the same day the National Association of Manufacturers of Pressed and Blown Glassware met in the same city in preparation for the wage conferences. On July 22nd the American Flint Glass Workers Union agreed with the association upon a 17½% wage cut in the pressed ware department.

Joseph J. Nester, Sr., head of the Obear-Nester Glass Company, St. Louis, Mo., died June 1st at the age of 78.

Frink Laboratories, Frink Decolorizer Co. and **R. L. Frink**, consulting glass technologist, who for years have maintained offices at Lancaster, O., recently announced their removal to Columbus, O., where mail may be addressed to P. O. Box 334.

Performance *talks*

1732 vs. 1932

In 200 years the Pot Furnace hasn't changed so much, but POTS surely have!

For instance, consider Buckeye Pot No. 5041, recently used in the furnace of the Canton Glass Co., Marion, Ind. Here's the record:

Set in furnace — November 15, 1930
Out of furnace — March 26, 1932
Life — 16 months, 11 days

Mostly crystal lime glass was melted, but also crystal, green, amber and opal.

This record is, of course, a high spot. But it does illustrate the fact that whatever conditions and practices are at *your* plant, Buckeye Pots will give you the very maximum of service. Try Buckeye Pots.

You will get better results if you buy your Fire Brick, Checker Tile, and High Temperature Mortars and Cements from the glass industry specialists.

LACLEDE-CHRISTY, ST. LOUIS, U. S. A.

Q2

Buckeye Pots

A LACLEDE-CHRISTY PRODUCT

Current Prices of Glass-Making Materials

July 22, 1932

Quotations furnished by various producers, manufacturers and dealers.

Acid	Carlots	Less Carlots
Citric (dom.) lb.	..	.30
Hydrochloric (HCl) 20° tanks, per 100 lb	..	1.10
Hydrofluoric (HF) 60% (lead carboy) lb	..	.13½
52% and 48% lb	.10	.10-.11¼
Nitric (HNO_3) 38° carboy ext. Per 100 lb	5.50	..
Sulphuric (H_2SO_4) 66° tank cars ton	15.50	..
Tartaric lb	..	.23½
Alcohol, denatured gal.	..	..
Aluminum hydrate ($Al(OH)_3$) lb	.04½-.05	05½-.06
Aluminum oxide (Al_2O_3) lb	..	.07
Ammonium bifluoride (NH_4) FHF lb	..	.15½
Ammonia water (NH_4OH) 26° drums lb		
Antimony, metallic (Sb) lb	.02½	.02¾
Antimony oxide (Sb_2O_3) lb	..	.09¾
Antimony sulphide (Sb_2S_3) lb	..	.08½
Arsenic trioxide (As_2O_3) (dense white), 99% lb	.04	.14 .04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh ton	47.00	..
90% through 100 mesh ton	44.00	..
Barium hydrate ($Ba(OH)_2$) lb.	..	.05¼
Barium mixture, glassmaker's, f.o.b. St. Louis ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$) lb.	..	.07¼
Barium selenite ($BaSeO_3$) lb.	..	..
Barium sulphate, in bags ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point, ton	15.00-16.00	18.00
Bone ash carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$) lb.		.02¼-.02¾
Granulated lb.	.02-.02½	.02¼-.02¾
Powdered lb.	.02¼-.02¾	..
Boric acid (H_3BO_3) lb.	.04¼-.05¼	..
Cadmium sulphide (CdS)—		
Red lb	..	.65-.90
Orange lb	..	.60-1.10
Yellow lb		1.30-1.50
Chromium oxide (Cr_2O_3) lb	.18½	.19
Cobalt oxide (Co_2O_3)		
In bbls. lb	..	1.25-1.45
In 10 lb. tins lb	..	1.35
Copper oxide		
Red (Cu_2O) lb	..	.25
Black (CuO) lb	..	.17-.19
Black prepared lb	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland Kryolith) lb	.09	.09¼
Synthetic (Artificial) lb	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb	..	1.15-1.20
*Feldspar—		
100 mesh ton	11.50-17.50	12.00-18.00
80 mesh ton	11.00-11.50	13.00
40 mesh ton	10.75-11.00	12.00
20 mesh ton	9.50-11.00	..
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2 2½%)		
Bulk, carlonds, f.o.b. mines ton	30.00	..
In bags or barrels ton	34.00	39.00
Imported ton	30.00-31.00	33.00-37.00
Formaldehyde lb	..	.07
Graphite (C) lb	..	04-.07
Iron oxide—		
Red (Fe_2O_3) lb	..	.0425
Black (FeO) lb	.04½	..
Kaolin (f.o.b. mine) ton	8.00-9.00	..
English, lump, f.o.b. New York ton	14.50-25.00	24.50-30.00

*Spot Shipments.

Kryolith (see Cryolite)	Carlots	Less Carlots
Lead chromate ($PbCrO_4$) lb.	..	.20
Lead oxide (Pb_3O_4) (red lead) lb.	.0515	.0625
Litharge (PbO) lb.	.0415	.0525
Lime—		
Hydrated ($Ca(OH)_2$) (in paper sacks) ton	5.50	..
Burnt (CaO) ground, in bulk ton	5.00	..
Burnt, ground, in paper sacks ton	7.00	..
Burnt, ground, in 280 lb. bbls. Per bbl.	2.15	..
Limestone ($CaCO_3$)	1.50-2.50	..
Magnesia (MgO)—		
Calcined, heavy (in bbls.) lb.	.06	.07
light (in bbls.) lb.	..	.23
extra light (in bbls.) lb.	..	.37
Magnesium carbonate ($MgCO_3$) lb.	.06	.10
Manganese 85% (MnO_2) lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content lb	..	.35
Nickel monoxide (NiO), green— for nickel content lb.	..	.35
Plaster of Paris, bags ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—		
Crystals lb.	.09	.09¼
Ground lb	.11	.12
Potassium carbonate—94-96% lb.	.0555	.0555
Calcined (K_2CO_3) 96-98% lb.	.06¼	.07
Hydrated 80-85% lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4) lb.	..	.25
Potassium hydrate (KOH) (caustic potash) lb.	.07¼	.08
Potassium nitrate (KNO_3) (gran.) lb.	..	.06-.06¼
Potassium permanganate ($KMnO_4$) lb.	.16½	.17½
Powdered blue lb.	..	1.35
Rochelle salts, bbls. lb.	..	.15
Rouge lb.	..	..
Rutile (TiO_2) powdered, 95% lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4) ton	22.00	..
Selenium (Se) lb.	..	1.70
Silver nitrate ($AgNO_3$) (100 oz.) per oz.	..	.20¼-.20¾
Soda ash (Na_2CO_3) dense, 58%—		
Bulk, on contract Flat per 100 lb	1.05	..
In barrels Per 100 lb	1.38	1.90-2.13
In bags Per 100 lb.	1.17½	1.72½-1.92½
Spot orders .. .025 per 100 lbs. higher	..	..
Sodium bichromate ($Na_2Cr_2O_7$) lb	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid Per 100 lb.	2.50	..
Sodium nitrate ($NaNO_3$)—		
Refined (gran.) in bbls. lb.	..	..
95 per cent. Per 100 lb.	1.67-177	1.72-1.82
Sodium selenite (Na_2SeO_3) lb	..	2.00
Sodium fluosilicate (Na_2SiF_6) lb.	.05½	.06
Sodium uranate (Na_2UO_4) Yellow or Orange lb.	..	1.50-1.55
Sulphur (S)—		
Flowers, in bbls. Per 100 lb	3.45	3.80-4.00
Flowers, in bags Per 100 lb	3.10	3.45-3.65
Flour, heavy in bbls. Per 100 lb	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals) lb	.27½	.29
Tin oxide (SnO_2) in bbls. lb	.28	.29½
Uranium oxide (UO_3) (black, 96% U_3O_8) 100 lb. lots. Black lb.	..	2.75
Yellow lb	..	1.50
Zinc oxide (ZnO) lb.	.03½	.12
American process. Bags lb.	.05¾	.06
Zircon		
Granular (Milled .005-.02c higher)	.07	.07½-.08
Crude. Gran. (Milled .005-.02c higher)	.03¼	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to June 24, 1932.

	May 1931 Quantity	May 1931 Value	May 1932 Quantity	May 1932 Value	Five Months Ending May 1931 Quantity	Five Months Ending May 1931 Value	Five Months Ending May 1932 Quantity	Five Months Ending May 1932 Value
Glass and glass products (Total)	.....	$629,203	.....	$359,218	.....	$3,434,746	.....	$1,901,385
Plate and window glass—								
Window glass, common, box 50 sq. ft.	687	4,034	105	712	5,995	21,058	766	4,621
Plate glass, unsilvered, sq. ft.	324,511	101,042	235,596	65,603	2,008,398	615,719	1,528,883	423,440
Other window and plate glass lbs.	385,208	36,647	55,522	11,940	1,539,525	167,683	529,978	65,686
Glass containers (bottles, vials and jars)	.....	176,560	.....	105,424	.....	957,250	.....	473,737
Table glassware, plain	.....	84,407	.....	50,394	.....	432,851	.....	225,454
Table and other glassware, cut or engraved	.....	13,173	.....	3,228	.....	39,275	.....	19,865
Lamp chimneys and lantern globes lbs.	.....	7,895	.....	6,527	.....	45,771	.....	32,223
Globes and shades for lighting fixtures lbs.	.....	40,213	.....	20,721	.....	199,819	.....	95,225
Chemical glassware lbs.	13,669	14,579	7,623	6,637	63,043	64,567	43,153	42,425
Electrical glassware, except for lighting lbs.	108,509	6,480	39,836	3,641	608,105	44,006	485,011	21,455
Other glassware	.....	144,173	.....	84,391	.....	846,747	.....	497,254

IMPORTS

Corrected to June 24, 1932.

Glass and glass products	.....	$526,710	.....	$226,501	.....	$2,528,616	.....	$1,339,565
Cylinder, crown, and sheet—								
Plain dut. lb.	498,918	18,461	264,029	9,284	3,891,808	152,732	1,310,987	45,727
Bent, beveled, colored, etc. dut. lb.	141,482	22,985	138,093	12,872	875,722	117,381	400,991	68,388
Plate glass dut. sq. ft.	572,272	174,768	78,681	16,085	2,168,697	650,239	657,341	116,740
Glass mirrors	105	318	1,382	522	676	1,657	3,356	2,552
Rolled, cylinder, crown, and sheet glass, ground, obscured, bent, beveled, colored, etc.	.....	10,191	.....	3,762	.....	26,860	.....	40,336
Laminated glass and manufactures, and plated glass	.....	283	.....	17	.....	4,082	.....	2,985
Bottles, vials, jars, and other containers	.....	36,410	.....	25,335	.....	215,117	.....	126,420
Scientific articles and utensils dut.	.....	38,237	.....	30,847	.....	161,222	.....	116,285
Tubes and rods dut.	.....	6,958	.....	5,475	.....	48,210	.....	32,298
Illuminating articles dut.	.....	29,022	.....	9,887	.....	155,895	.....	79,240
Blown glass articles—								
Bulbs for electric lamps, without filament dut.	1,041,569	10,447	896,949	6,930	6,119,558	59,885	5,625,889	45,181
Other blown glass articles dut.	.....	95,645	.....	52,514	.....	533,563	.....	355,566
Pressed glass articles	.....	4,901	.....	7,672	.....	50,948	.....	46,952
Other glassware	.....	78,084	.....	45,299	.....	350,825	.....	260,895